A ONE-YEAR CROSS-SECTIONAL OBSERVATION STUDY OF THE ACUTE MANAGEMENT OF ADULT MILD HEAD INJURY IN THE EMERGENCY DEPARTMENT HOSPITAL UNIVERSITI SAINS MALAYSIA

by

DR CHAN HIANG CHUAN

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LIST OF ABBREVIATIONS:

CT: Computed Tomography

ED: Emergency Department

EEG: Electroencephalogram

ENT: Ear, Nose and Throat

GCS: Glasgow Coma Scale

HUSM: Hospital Universiti Sains Malaysia

LOC: Loss of Consciousness

MHI: Mild Head Injury

MRI: Magnetc Reasonants Imaging

NES: Non-epileptic seizure

OR: Odds Ratio

ABSTRAK

RAWATAN AKUT KECEDERAAN RINGAN OTAK ORANG DEWASA PENYELIDIKAN PEMERHATIAN SECARA 'CROSS-SECTION'

PENGENALAN:

Kecederaan Ringan Otak (MHI) merupakan salah satu presentasi yang agak biasa kepada Jabatan Kecemasan. Kebanyakan pesakit dengan MHI akan sembuh dengan sepenuhnya. Akan tetapi, sebilangan kecil pesakit yang mengalami pembekuan darah dalam otak , akan menjadi lebih serius jika tidak dikenalpasti pada awal. Bagi mereka dengan kecederaan otak yang telah menjadi serius, kesudahan dari segi neurologi adalah kurang memuaskan.

OBJEKTIF:

Antara tujuan penyelidikan ini ialah,

I) yang pertama adalah untuk mengukur sejauh mana nilai-nilai klinikal dapat membantu kita menjangkakan kecederaan otak bagi pesakit MHI,

II) yang kedua adalah untuk menentukan penggunaan CT skan kepala sama ada scara pilihan atau untuk semua pesakit MHI,

III) yang ketiga adalah untuk mengetahui perbezaan antara pesakit dengan GCS 13,14 dan 15,

IV) yang ke-empat adalah untuk mengenalpastikan pesakit yang berisko tinggi sebelum keadaan pesakit menjadi lebih teruk oleh kerana

kesudahan dari segi neurologi adalah kurang memuaskan, dan

V) akhir sekali adalah untuk mengetahui berapa banyak kes kecederaan kepala yang tidak dapat dikenalpasti dengan amalan setakat ini.

KAEDAH:

Sebanyak 330 pesakit dengan GCS permulaan 13-15 dan kejadian kecederaan berlaku dalam masa 24 jam, dikumpulkan dari 1hb Januari hingga 31hb Disember tahun 2000 di Jabatan Kecemasan Hospital Universiti Sains Malaysia.

Nilai-nilai klinikal yang dikaji bagi setiap pesakit iaitu kejadian tak sedar diri (LOC), kesakitan kepala yang sederhana hingga teruk, muntah 2 kali atau lebih, pendarahan dari telinga/hidung/tekak (ENT), x-ray menunjukkan tengkorak pecah, kecacatan neurologi setempat, sawan selepas kecederaan, mekanisma kecederaan, pengaruh alkohol dan dadah, sejarah perubatan yang berkaitan dan umur melebihi 60 tahun, dicatat dengan lengkap dalam kertas soal-selidik. Tanda-tanda penting, kecederaan systemic dan faKtor-faktor lain yang berkaitan juga diambil kira.

Bagi pesakit di mana CT skan kepala dibuat, indikasi dan penemuan normal/tak normal dicatatkan. Jenis rawatan permulaan untuk setiap pesakit adalah ditentukan. Untuk pesakit yang dimasukkan ke hospital terutama bagi mereka yang tidak menjalani CT skan kepala, perkembangan pesakit dalam wad di-ikuti hingga pesakit dibenarkan keluar hospital untuk mengetahui morbiditi dan kematian pesakit jika ada.

Data yang dikumpulkan dianalisa dengan kajian 'descriptive'. Analisa 'chi-square' dan ' binary logistic regression' juga digunakan untuk menentukan kesahihan nilai-nilai klinikal berhubung dengan penemuan CT kepala dan juga rawatan permulaan. Nilai $p < 0.05$ diambil kira sebagai bermakna.

KEPUTUSAN:

Keputusan penyelidikan adalah terutama sekali untuk mengingatkan kakitangan Jabatan Kecemasan khasnya dan kakitangan dalam wad amnya mengenai pesakit yang lebih berkemungkinan besar mendapat kecederaan otak yang serius di mana mereka mempunyai patho-fisiologi, tahap kecederaan dan kesudahan yang berbeza dalam kumpulan MHI yang dianggap besar.

Dari penyelidikan ini, kami mendapati yang berikut:

1) insidence tengkorak pecah dalam x-ray adalah agak tinggi iaitu sebanyak 13.3%
2) insidence CT skan kepala yang abnormal adalah 24.8% walaupun hanya 31.8% pesakit yang menjalani penyiasatan tersebut. Ini bermakna, 78.1% pesakit yang menjalani CT skan kepala, mengalami kecederaan otak yang memerlukan rawatan sama ada secara perubatan atau pembedahan.
3) Tengkorak pecah dan pendarahan ENT yang berterusan adalah antara dua factor terpenting yang berkaitan rapat dengan CT skan kepala yang tak normal dengan nilai $p < 0.001$ dan 0.04 masing-masing.
4) LOC, sakit kepala, muntah, kecederaan 'maxillo-facial', size anak

mata yang berbeza, umur > 60 tahun, penyalah-gunaan dadah/alkohol, hilang ingatan, dan sawan adalah tidak significant dari segi statistik.

5) Peratusan CT kepala yang tak normal adalah berbeza di antara pesakit yang mempunyai GCS yang berbeza seperti berikut; 62.5%, 74.2% dan 89.7% bagi GCS 15, 14 dan 13 masing-masing.
6) Perbezaan di antara GCS 13 dan 15 dari segi CT skan kepala yang tak normal adalah penting dari segi statistik dengan nilai $p < 0.02$.
7) Pesakit dengan GCS 13 dan 14 adalah lebih berisiko dari segi menjalani rawatan perubatan atau pembedahan jika berbanding pesakit dengan GCS 15. Kedua-dua perbandingan tersebut mempunyai nilai $p < 0.001$.
8) Keadaan 7 pesakit (2.1%) menjadi lebih teruk di dalam wad. Hanya 2 pesakit yang tidak menjalani CT skan kepala yang awal. 6 daripada 7 pesakit tersebut mempunyai GCS < 15 pada mulanya. Semua pesakit tersebut mempunyai sekurang-kurangnya satu risiko yang dikaji.

KESIMPULAN:

Berdasarkan kepada keputusan di atas, panduan berikut adalah dicadangkan:

1) penggunaan x-ray kepala untuk pesakit MHI buat masa ini patut dikekalkan. Tidak ada cara yang lebih baik untuk mengenalpastikan tengkorak pecah melainkan dengan x-ray.
2) Penggunaan CT skan kepala secara selektif berpandukan protocol

yang sedia ada adalah memadai di samping dapat mengurangkan kos rawatan yang semakin meningkat.

3) Nilai-nilai klinikal adalah sangat berguna dalam meramal kecederaan kepala yang akut dan tertanguh. Pesakit yang dianggap ber-risiko tinggi patut mendapat pemerhatian yang lebih kerap dalam ward dan menjalani CT skan kepala bila perlu untuk mengurangkan morbiditi dan juga mortaliti pesakit.

4) Pesakit yang mempunyai GCS berlainan dalam MHI mempunyai patho-fisiologi, tahap kecederaan kepala dan kesudahan yang berbeza. Pertimbangan yang serius perlu diambil untuk mengasingkan pesakit dengan GCS 13 dan mungkin juga GCS 14 dari pesakit dengan GCS 15.

5) Pesakit dengan GCS 15 dan GCS 14, dengan tanda-tanda minimal boleh diperhatikan di wad pemerhatian Jabatan Kecemasan daripada memasukkan semua pesakit MHI ke dalam wad.

ABSTRACT

ACUTE MANAGEMENT OF ADULT MILD HEAD INJURY

A CROSS-SECTIONAL OBSERVATION STUDY

INTRODUCTION:

Mild Head Injury (MHI) is one of the common presentation to Emergency Department. Most MHI patients recover fully but there is a significant proportion of them harbor intracranial hematoma that might deteriorate if the diagnosis is missed. The Neurological outcome of MHI patients are less favorable once deteriorated.

OBJECTIVES:

The objectives of this study are;

I) to assess whether clinical parameters are useful to predict the likelihood of intracranial injury,

II) to determine the justification of selective use of cranial CT scans versus cranial CT for all MHI patients,

III) to evaluate the differences between patients with GCS 13, 14 and 15,

IV) ability to identify patients at risk before deterioration as neurological outcome are less favourable and

V) to find out the incidence of missed intracranial injury in our current practice.

METHODOLOGY:

330 adult patients with initial Glasgow Coma Scale of 13-15 presented within 24 hours after blunt head trauma were collected from 1st January to 31st December 2000 at Hospital University Science Malaysia Emergency Department.

For every patient, a standard questionnaires is used to document clinical parameters under study i.e. Loss of consciousness, moderate to severe headache, vomiting twice or more, Ear Nose and Throat bleed, skull fracture on plain radiograph, focal neurological deficit, post-traumatic seizure, mechanism of injury, alcohol or drug influences, significant past medical history and age > 60 years. Patient vital signs, systemic injury/injuries and other relevant factors are also noted.

For those with cranial Computed Tomography scan done, the indication and finding (normal/abnormal) are documented. Each patient's modality of initial management is also determined. Patients who are admitted, especially those with no initial cranial CT done, will be followed up till discharge to detect any late deterioration including morbidity and mortality. Neurological charting, hemodynamic status and other relevant information in the ward are also noted.

The data are analyzed using various descriptive studies. Chi-square analysis and Binary logistic regression are used to determine the significant of each clinical predictor in relation to cranial CT abnormality and mode of management. Level of significance is taken as p-value < 0.05.

RESULTS

The result of this study is to highlight the awareness of the staff of Emergency Department and the in-patient team regarding which patients at higher risk of developing life-threatening intracranial injury in Mild Head Injury, which have different pathophysiology, severity and clinical outcome within this broad group.

From this study, it was found that:

1. Incidence of skull fracture on plain radiograph, 13.3% was relatively high.
2. There was 24.8% of abnormal cranial CT scan though only 31.8% of the sample underwent the investigation. Thus, 78.1% of those with cranial CT scans done, had acute intracranial injury which need medical or neurosurgery intervention.
3. Skull fracture and persistent ENT bleed are the two risk factors that are strongly associated with abnormal cranial CT scan statistically. (with $p<0.001$ and 0.04 respectively).
4. LOC, headache, vomiting, maxillo-facial injury, unequal pupils, age > 60 years old, substance influence, amnesia and seizure are not statistically significant.
5. Percentage of obtaining abnormal cranial CT scan vary with GCS score; 62.5%, 74.2% and 89.7% of abnormal CT for GCS 15, 14 and 13 respectively.
6. Statistically, there is significant difference between GCS 13 and 15

of obtaining abnormal cranial CT with $p < 0.02$.

7. Patients with GCS 13 and 14 have higher chance of undergoing medical or neurosurgery intervention when compare to GCS15 with both have $p < 0.001$.
8. 7 patients (2.1%) deteriorated in the ward. 2 patients had no initial CT scan done. 6 out of 7 patients that deteriorated had GCS < 15. All the patients had one or more risk factors that are involved in the study.

CONCLUSION:

Based on the results of this study, the following guidelines have been proposed:

1. Current practice in regard to the use of plain skull radiograph in MHI should be continued. There is no practical way to diagnose skull fracture except radiologically.
2. Selective use of cranial CT scan for MHI is justified based on current standard of practice and to reduce escalating medical cost
3. Clinical parameters are useful to predict acute and delayed intracranial injury. Patients deemed at higher risk should have more closed neurological observation and even early cranial CT scan when indicated to prevent deterioration.
4. There is heterogeneity between patients with different GCS in MHI in term of pathophysiology, severity of injury and clinical outcome. Serious consideration must be given to the segregation of patients with GCS 13 and even 14 from those with GCS 15.

5. Patients with GCS 15 and GCS 14 without or with minimal symptoms can be observed at ED observation ward instead of admission.

CHAPTER 1:

INTRODUCTION

1. INTRODUCTION:

MHI is a very common neurologic condition with estimate suggesting an incidence of 180 per 100,000 people (Kurtzke and Kurland, 1993). Approximately 15% of these patients or 27 per 100,000 will have disabling symptoms 1 year after their head injury (Mclean et al, 1983, Rutherford 1989). In another population study, about 200 per 100,000 patients with head injury require hospital admission; 50% to 80% of these patients had sustained MHI (Annegers et al 1980, Vollmer & Dacey 1991). In addition, there are as many as 20% to 40% of patients with mild head injury that do not seek medical care (Frankowski et al, 1985).

The Head Injury Interdisciplinary Special Interest Group of the American Congress of rehabilitation Medicine defines Mild Head Injury (MHI) as 'a traumatically induced physiologic disruption of brain function', as manifested by one of the followings:

i) any period of loss of consciousness (LOC)

ii) any loss of memory for events immediately or before the accident

iii) any alteration in mental state at the time of the accident

iv) focal neurologic deficit, which may or may not be transient

(Berrol S 1992, Rosental M 1993)

MHI has been arbitrarily defined as a Glasgow Coma Scale (GCS) score of 13 to 15. There is conflicting opinion between researcher that patients with a GCS of 13 & 14, who have cognitive deficits should be grouped with the 'normal' patients who has a GCS of 15 (Rimel et al, 1982).

Significant controversy continues regarding the best strategy for patients with MHI in particular regarding the indication of CT scan of the brain; selective use versus CT for all MHI, because of the concerns that these patients may harbor an intracranial lesion that requires either medical or neurosurgical intervention. The use of plain skull radiograph had also been debated between Emergency Physician, Neurosurgeon and Neuro-radiologist regarding its low yield and high utilization.

In addition, because of the large numbers of patients with MHI and nearly one half of all patients are between the ages of 15 to 34 years old (Jennett and Frankowski, 1990), the psychosocial aspect and economic burden of patient's care with disabling symptoms cannot be ignored.

Further more, for most patients with MHI who present to Emergency Department (ED), it is important that ED physicians have a clear direction on how to proceed in their evaluation and management. It has been stated that improvement in morbidity and mortality from traumatic brain injury WOULD NOT come from added technology & advanced care of patients with Severe Head Injury (Klauber et al, 1989). Thus, early identifying and preventing deterioration for patients with MHI should be the goal.

Keeping this in mind, this study is planned with the following objectives;

i) To assess whether clinical parameters are helpful to predict the likelihood of intracranial injury.

ii) To determine the justification of selective use of cranial CT scan versus CT scan for all MHI patients

iii) To further assess and determine the differences if any between patients with GCS 15, 14 and 13 so that emphasis and resources can be utilized more optimally.

iv) To be able to identify patients at risk BEFORE deterioration take place as the neurological outcome for those who had deteriorated are less favorable than those with the same GCS.

v) To determine the incidence of missed intracranial injury in order to improve the efficiency and standardization of Emergency Department (ED) care through guidelines or clinical decision rules.

With the objectives above, the ultimate aims of this study are;

i) To enable ED staff to have a clear direction on how to proceed in their evaluation of MHI patients.

ii) To draw protocol or guidelines for ED to aid in the management of MHI patients especially whether to discharge or admit patients.

iii) To enlighten the awareness of in-patient team regarding the frequency of neurological observation and length of admission.

iv) To revise and establish the role of ED observation ward instead of hospitalization for all MHI patients.

CHAPTER 2:

METHODOLOGY

2. METHODOLOGY:

All adult patients aged more than 12 years old with the initial Glasgow Coma Scale of 13 to 15 with stable hemodynamic, were enrolled in this study. The incidence leading to Mild Head Injury must be within 24 hours period. The study period was for one year conducted from 1st January 2000 to 31st December 2000 at Emergency Department Hospital University Science Malaysia (HUSM), which is the referral center for neurosurgical cases for the States of Kelantan, Terengganu, and part of the State of Pahang. This study was approved by the Hospital USM Ethical Committee.

The Glasgow Coma Scale (GCS) used is the sum of scores for three areas of assessment;

i) Eye opening

ii) Best motor response

iii) Verbal response

i) Eye opening response; scoring of eye opening is not valid if the eyes are swollen shut.

a) 4 points: spontaneous, already open with blinking

b) 3 points: to speech, not necessary to a request for eye opening

c) 2 points: to pain, stimulus should not applied to face

d) 1 point: none

ii) Best motor response; the best response obtained for any extremity is recorded even though worse responses may be present in other extremities. For patients not following verbal command, a painful stimulus is applied to the fingernail or toenail.

a) 6 points: obeys, move limb to command and pain is not required

b) 5 points: localizes, changing the location of pain stimulus causes purposeful motion toward the stimulus

c) 4 points: withdrawal, pulls away from painful stimulus

d) 3 points: abnormal flexion, decorticate posture

e) 2 points: extensor response, decerebrate posture

f) 1 point: no movement

iii) Verbal response; scoring of verbal response is invalid if speech is impossible.

a) 5 points: orientated, knows person, place and time

b) 4 points: confused conversation, still answer question.

c) 3 points: inappropriate words, speech is either exclamatory or random but recognizable words are produced.

d) 2 points: incomprehensible sounds, grunts and groans are produced, but no actual words are uttered, it should not be confuse with partial respiratory obstruction.

e) 1 point: none

All the patients are assessed upon their attendance to Emergency Department. After ascertain the GCS to be between 13-15, other vital informations that need to be gathered are as follow:

1) pupil size and reactivity to light of both pupils
2) hemodynamic status i.e. blood pressure & pulse rate
3) thorough systemic examination to identify trauma to other systems which might confound the study group in particular intra-abdominal injury or pelvic injury that cause unstable hemodynamic status which interfere with GCS scoring.
4) ascertain the presence of any of the following risk factors that are involved in this study:
    - loss of consciousness(LOC)
    - headache
    - vomiting
    - unequal pupils
    - ENT bleed
    - focal neurological deficit
    - radiological skull fracture
    - alcohol consumption

9) Any other relevant information.

{NB: for full detail of questionnaires please refer to appendix}

Data obtained in this study were analysed with Descriptive Studies from SPSS® software, version 9.0. Chi-square analysis and Binary Logistic Regression were used to assess each clinical parameter in relation to cranial CT findings and modalities of management. P value < 0.05 was taken as statistically significant.

2.1 TERMINOLOGY USED IN THE STUDY

The following are definition of some of the terms used in the study:

MILD HEAD INJURY (MHI):

Refer to patient with GCS 13-15. Other terms such as Minor or Minimal Head Injury are not used to avoid confusion.

FOCAL NEUROLOGICAL DEFICIT:

If patient have facial asymmetry, hemiplegia/hemiparesis, hemisensory loss, positive Babinski sign or abnormal reflex (hyper/hyporeflex).

DETERIORATION:

Drop in GCS by 2 points or more

Neurological deficit; either new deficit or progressive

AMNESIA:

Unable to remember or describe the incident that lead to head trauma or event after the trauma in the history

HEADACHE:

Subjective, either localized or generalized and of moderate to severe in intensity.

MEDICAL THERAPY:

Patient require supplemental oxygen, anticonvulsant, osmotic diuretic or antibiotic prophylaxis for base of skull fracture.

NEUROSURGICAL INTERVENTION:

Include ICP monitoring, craniotomy or craniectomy for clots evacuation, debridement, decompression or EVD (external ventricular drainage).

NEUROLOGICAL OBSERVATION:

Particular attention to GCS charting, pupils response, blood pressure, pulse rate and new or progressive neurological deficit.

POLYTRAUMA:

Refers to significant trauma involving two or more organ systems.

COAGULATION DISORDER:

Patient on anticoagulation treatment or patient who has bleeding disorder.

SEIZURE:

Either from the history or witness seizure after the trauma event. Need to verify whether patient is suffering from epilepsy or on anti-epileptic medication. Known epileptic patients will be excluded.

ALCOHOL INFLUENCE:

Base on patient history, eyewitness or suggestive findings on physical examination such as odor of alcohol, confusion, slurred speech or unsteady gait.

RETURN VISIT:

MHI patients with return to Emergency Department within a 24-hour period.

LOSS OF CONSCIOUSNESS:

This is determined from the information gathered from the history or the eyewitness. Duration of LOC is not counted as most patient or relative unable to tell the exact duration.

MECHANISM OF INJURY:

Whether they are motor vehicle accident, fall, assault, occupational/ industrial accident or sport related injury.

SKULL PLAIN RADIOGRAPH FINDINGS:

The findings are either normal, linear or depressed skull fracture or uncertain.

CRANIAL CT SCAN:

All cranial CT scans are reviewed and reported by the Radiologist and they are blinded from the study. The cranial CT is considered abnormal if the followings are present:

i) extradural hematoma,

ii) subdural hematoma,

iii) intracerebral contusion,

iv) brain parenchymal hematoma,

v) subarachnoid hemorrhage,

vi) intraventricular bleed,

vii) skull fracture,

viii) cerebral edema,

ix) combination of two or more of the findings above.

MAXILLO-FACIAL TRAUMA:

If the patient have facial swelling, bruises, lacerated wound or evidence of fracture involving orbits, maxilla, zygoma or mandible.

CHAPTER 3:

LITERATURE REVIEW

3. LITERATURE REVIEW.

3.1 Overview

Data from the Head Injury Task Force, National Institute of Neurologic Disorder and Stroke estimate that there are 2,000,000 cases of traumatic brain injury in the United States per year with approximately 500,000 patients requiring hospitalization. About 100,000 American die as a result of this brain injury with most of these deaths occurring within several hours from the time of the accident. Of the survivors, 70,000 to 90,000 will experience some sort of lifetime debilitation and 2000 will live in a persistent vegetative state. The economic cost of traumatic brain injury in the United States is estimated to exceed $25 billion annually (Borczuk P, 1997).

Regarding the pathophysiology, Mild Head Injury (MHI) is usually the result of a sudden deceleration injury or a rotational acceleration injury that has generated shearing forces within the brain (Holbourn, 1943; Strich,1961;White and Krause, 1993). These forces disrupt small blood vessels as well as axons at the interface between gray and white matter, with the depth of injury related to the energy transferred during the trauma (Lwvin et al, 1988). Injury to small vessels manifests themselves as petechial hemorrhages or focal edema, whereas disruption of bridging veins, seen especially in the elderly, can result in subdural hematomas. The pattern of white matter changes is termed diffuse axonal injury and involves the deep parasagital areas, frontal and temporal cortex, and brain stem. The initial trauma does not cause direct axonal tearing but instead affect intra-axonal neurofilament organization which in turn impairs axonal transport and leads to axonal swelling, Wallerian degeneration and transection (Povlishock and Kontos, 1895; Povlishock J, 1993). The initial axonal damage progresses over the initial 6 to 12 hours, with a loss of intracellular K+ and Mg++ and an accumulation of intracellular Ca++(Siejso et al, 1989; Siejso BK, 1993). The calcium activates phospholipases, which can generate oxygen radicals via the metabolism of arachidonic acid, resulting in damage to membrane via lipid peroxidation (Kontos and Povlishock, 1986). Excitatory neurotransmitter, such as glutamate or aspartate may contribute to secondary insults. These substances can activate N-methyl-D-Aspartate (NMDA) receptors and cause further influx of calcium and efflux of K+, thus perpetuating neuronal injury.

As many as 50% of patients with MHI may suffer from the postconcussion syndrome (Evans, 1992). These include symptoms such as headache, dizziness, difficulty with memory or unable to concentrate, depression and other symptoms including those referable to the peripheral vestibular systems (Binder, 1988; Rutherford, 1989). Decreased ability to smell and taste are reported in 5% of these patients (Minderhoud et al, 1980). The risk of seizures within 5 years for MHI with no skull fracture has been estimated to be 0.8% (no greater than the general population) (Annegers et al, 1980).

Those who are at lowest risk for developing a postconcussion syndrome are well-motivated, young patients who had no LOC. Patients who have brief LOC, who are dazed or who have posttraumatic amnesia of less than an hour and a GCS of 15 are likely to recover in 6 to 12 weeks. Those more than 55 years or who have prolonged post-traumatic amnesia may require months to clear (Mazzuchi et al, 1992). In general, by one year 85-90% of patients will have full recovery, although they may have subjective feeling of reduced mental functioning. After 1 year, the remaining patients are classified as having persistent postconcussive syndrome (PPCS) (Rutherford et al, 1978). Predictors of PPCS include female, low socioeconomic status, ongoing litigation serious illness, alcohol abuse, or prior MHI (Edna and Cappelen, 1987).
Malingers constitute a small minority of patients with complaints and patients with litigation or compensation claims are not cured by a verdict (Mendelson, 1982).

The general goal in the management of patients with acute head trauma is to minimize further brain injury from secondary insults such as hypotension, hypoxia, seizure and infection. Once the patients with MHI has been assessed and stabilized, the challenge is to identify which of these patients belong to the very small subset harboring an intracranial lesion.

3.2 Role of Plain Skull Radiograph in MHI

Many radiologists in Britain and the United States think that a substantial reduction in the routine use of skull radiography in the initial management of head injury would not lead to an increase in the incidence of secondary brain damage (Bell & Loop,1971; Boulis,1978; Evans,1977; Eyes & Evans 1978; Master, 1980; Phillips, 1979; Royal College of Radiologists, 1980). The reasons for this are that the present high utilization cannot be justified by the very low yield (Boulis et al, 1978; Galbraith, 1981; Royal College of Radiologists, 1980) of patients with successfully diagnosed and managed intracranial haematomas and infection (Evans, 1977; Eyes & Evans 1978; Master, 1980), and a real doubt about the diagnostic accuracy of skull radiography as a means of detecting skull fracture. Opponents of this view point out that the presence of a skull fracture is associated with a 200-fold increase in the risk of intracranial hematoma (Gaibraith et al, 1981) and claim on economic grounds that utilization of skull radiography should be kept at its present level because a reduction may result in more admissions thus increase costs (Gaibraith et al1981;Jennet,1980).

The Royal College of Radiologist (1981) studied the use of skull radiography in the management of patients with head injury. Patients were divided into 3 groups: i) patients with complicated head injury (a head injury with additional injury or pathological finding), ii) uncomplicated head injury and clinically negative, iii) uncomplicated head injury and clinically positive (cerebrospinal fluid and/or blood discharge from nose; hemotypanum and/or fluid discharge from ear; any time unconscious, altered state of consciousness now or other focal signs or symptoms). The yield of potentially important radiological findings in 4829 patients with UNCOMPLICATED head injury was 2 basal, 1 frontal and 64 vault fractures. In 4 of these patients, intracranial hematomas developed, of which 3 would have been suspected clinically and the patients admitted for observation even if skull radiography had not been available. Thus, only 1 in 4800 patients of unsuspected intracranial hematoma with skull fracture among patients with uncomplicated head injury. The radiological cost of identifying this 1 patient in the series was 43,200-pound Sterling (1981).

In 1983, Royal College of Radiologist (1983) further evaluated the cost and benefits of six different patients selection guidelines for skull radiography in uncomplicated head injury involving 4829 patients. They found out that with the most conservative guideline 94% of patients with vault fracture and all those in whom outcome was serious (depressed, basal or frontal fracture, intracranial hematoma, pneumocephalus or death) would be radiographed, at a saving of 21.3% on radiological costs incurred by current practice. At the other extreme is a guideline, which embraced 58.2% of patients with vault fracture and 85% of patients with serious outcome at a saving of 72.9%. The range of guideline permits the reader to explore his own preference and become aware of the implication of his choice.

Gorman D.F, 1987 collected 12,395 Emergency Department attendees with head injury to assess the utility of post-traumatic skull X-rays. From the study, there were 3.8% of skull fracture or diastases. Characteristics which were significantly more common in patients who had skull fractures on the X-ray were: recent alcohol consumption, initial unconsciousness, amnesia of any duration, vomiting, neurological signs, injuries sustained by pedestrians, motorcyclists and bicyclists. The relative risk of a patient with a skull fracture on X-ray developing an acute hematoma was 164 times more than patient without a skull fracture. The presence or absence of a skull fracture cannot be determined clinically in the 99% of head injured patients. It was considered that, in the majority of individual patients with head injuries, accurate clinical diagnosis of radiologically apparent fractures was not possible. In view of this and in the light of the known risks in patients with fractures, it was concluded that skull X-rays should continue to be used relatively freely in the management of these patients.

Meta-analysis by Hofman et al, 2000 confirms that demonstration of a skull fracture increases the risk of significant intracranial hemorrhage by five-fold, not a factor of 40, more in line with other studies. It has been suggested that radiographs can be used to obviate admission and observation in doubtful cases.

Feuerman et al 1988, noted that, provided clinical assessment was adequate, nothing was gained from radiography. Indeed, they suggested that a patient with a Glasgow Coma score of 15, shown to have a linear fracture of the skull, could be discharged to the care of a responsible companion.

Guidelines issued by the Royal College of Radiologists, 1980 unequivocally reject both skull radiography and CT for patients thought to have a "low risk" of intracranial injury (although neither the low risk nor the degree of risk is defined). They also discard the triage value of the skull film, indicating that patients who cannot be placed in the care of a "responsible adult" may be admitted for observation rather than undergoing imaging. The recommendation for patients with a "medium risk" is indecisive, suggesting skull radiography or CT. The presence of a skull fracture is said to transform the risk to "high", thereby indicating CT, a recommendation still based on the presumed 40-fold increase in risk.

In the United States, more than half the hospitals in a nationwide survey reported that they rarely used skull radiography for head injuries (Hackney, 1991); CT was preferred when the clinical condition reasonably raises concern about a treatable intracranial hemorrhage. Clearly, one would wish the threshold for suspicion to be such that there were few negative examinations, but that patient who needed scanning was not overlooked. The extra efforts required to organize emergency CT rather than skull films might effectively discourage poorly indicated requests.

3.3 Post-traumatic Amnesia versus GCS in predicting Outcome after Head Injury

The period of post-traumatic amnesia is usually defined as the time between receiving a head injury and the resumption of normal continuous memory (Lezak, 1983;Russell, 1961; Whitty, 1977). Post-traumatic amnesia and the Glasgow coma scale (GCS) are widely considered the two best single predictors of outcome after head injury. The GCS is most useful when a patient is first admitted to hospital (Teasdale and Jennett, 1976) and cannot be used as a retrospective measure of severity of head injury. The facts that post-traumatic amnesia can be assessed relatively quickly and after the recovery of the patient are therefore major clinical advantages (Williams et al, 1984).
In addition, some patients have significant post-traumatic amnesia with short or negligible coma. In these circumstances, the amnesia correlates better than GCS with radiological measures of severity of head injury (Wilson et al, 1993).

Russell and Smith, 1961 put forward a taxonomy of severity of head injury based on post-traumatic amnesia as follows: i) mild head injury: post-traumatic amnesia less than one hour, ii) moderate head injury: post-traumatic amnesia between one and 24 hours, iii) severe head injury: post-traumatic amnesia between one and seven days; and iv) very severe head injury: post-traumatic amnesia more than seven days. Used as a broad measure of severity of head injury, post-traumatic amnesia has consistently shown an ability to predict important outcomes. Day to day living abilities (as measured by the

Glasgow Outcome Scale), have shown good correlation with duration of post-traumatic amnesia. Similarly, a range of neuropsychological performance variables has shown a strong relation with duration of amnesia (Karzmark, 1992).

Difficulties in measuring post-traumatic amnesia have been well documented. It can be underestimated due to "islands of memory" (Whitty and Zangwill, 1977). These are recollections of isolated events, and are reported by about one third of patients with mild and moderate head injury (Gronwall and Wrightson, 1980). It can also be underestimated if the patients are deemed to be out of post-traumatic amnesia once they are oriented in time and place.

Gronwall and Wrightson,1980 suggested that post-traumatic amnesia could be overestimated by including periods of natural sleep or impaired consciousness due to medication, alcohol, or drugs. It seems, for some, to end sharply and to coincide with a memorable event such as being in an ambulance, leaving hospital, or going home. For others, recovery seems to be a slow and protracted process. This variability can further complicate its measurement.

Clinically, post-traumatic amnesia is invariably measured by asking the patient to recall in chronological order, the events they can remember after their injury (Gronwall and Wrightson, 1980). This method, although widely used, presents difficulties. Firstly, much of the published literature does not describe the procedure or protocol used. Secondly, when used in MHI, test-retest reliability can be poor (Forrester et al, 1994; Schacter & Crovity, 1977). Although this is an important finding, its clinical relevance is probably limited, because few clinicians use post-traumatic amnesia as a fine-grained measure of severity of head injury. The use of post-traumatic amnesia as a broad measure of severity is, however, widespread and it is an integral part of most neurological and neuropsychological assessments. The reliability of measuring post-traumatic amnesia byretrospective questions across the full range of severity of head injury thus has great clinical importance.

3.4 Utilization of Cranial Computed Tomography (CT) Scan in MHI

The role of cranial CT scanning for patients with MHI remains controversial. Some author claim there should be universal scanning for this group of patients because as many as 20% will have scans documenting the presence of intracranial injury. Other states that the low prevalence of neurosurgical intervention in these patients makes CT scanning of all low risk patients an inefficient use of resources.

1n 1987, Master and colleagues reported the results of a prospective, multi-center trial of 7035 head trauma patients with a goal to validate a management strategy for radiological imaging. This strategy was the result of a multidisciplinary expert panel consisting of Radiologists, Neurosurgeons, Emergency Physicians, Pediatricians, and Family

Practitioners. Patients were divided into low, moderate, and high-risk groups.

A) Low risk group:

Possible findings:

Asymptomatic
Headache
Dizziness
Scalp hematoma
Scalp laceration
Scalp contusion or abrasion
Absence of moderate-risk or high-risk criteria

Recommendations:

Observation alone:

Discharge patients with head injury information sheet and a second person to observe them.

B) Moderate-risk group:

Possible findings:

History of change of consciousness at the time of injury or subsequently.
History of progressive headache
Alcohol or drug intoxication
Unreliable or inadequate history
Age younger than 2 years
Post-traumatic seizure
Multiple trauma
Serious facial injury
Signs of basal skull fracture
Possible skull penetration or depressed fracture

Suspected physical child abuse

Recommendations:

Extended close observation; watch for signs of high-risk group
Consider CT examination and neurosurgical consultation
Skull series may (rarely) be helpful if possible but do not exclude intracranial injury.

C) High-risk group:

Possible findings:

Depressed level of consciousness not clearly due to alcohol, drugs or other cause (i.e. metabolic or seizure disorders)
Focal neurological signs
Decreasing level of consciousness
Penetrating skull injury or palpable depressed fracture

Recommendations:

Patient is a candidate for Neurosurgical consultation, emergency CT scan or both.

Although there were some patients (12/2795 or 0.4%) in the low risk group who had simple skull fracture on plain films, no patient had evidence of intracranial injury. They recommended that patients in this low-risk group did not need any radiological study and could be discharged home with a qualified observer. The major criticism of this study was the lack of follow-up data on 3041 patients. However, despite the lack of follow-up, the authors estimated